

Effect of Ankle Foot Orthosis on Balance and Locomotion in Stroke Patients

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Abstract

Background and Introduction: Stroke is one of the common wellbeing problems that are handicapping. The consequences can be viewed as massive disturbance in information, processing, causing and conduct issues. Despite the fact that Ankle Foot Orthosis should effectively work in regaining functional ability and provide base of support which helps in improving the efficiency of walking, there are very few studies analyzing the effect of AFO. Thus, the present study aims to evaluate the effect of AFO on locomotion and balance in stroke patients. *Subjects and Methods:* In the current experimental study 30 patients were divided into two groups 1) Experimental group (with AFO), 2) Control group (without AFO). Both the groups were provided with lower limb strengthening exercises, treadmill training, spasticity reducing exercises, reaching in standing and sitting, balance and locomotion training, stair ascent and descent. *Results:* In both groups the mode of Functional Ambulation Category (FAC) is 2. For Group A, Berg Balance Scale (BBS) the mean is 26.00 ± 3.047 . For Group B, is 28.27 ± 4.431 . The range of BBS in both groups is 23–37. In 6 mt walk test the mean for Group A, is 17.20 ± 2.178 . For Group B the mean is 18.27 ± 1.792 . The post result values of BBS Group A, mean is 30.60 ± 3.661 . The correlation is 0.935. For Group B, mean is 31.93 ± 4.877 . The correlation is 0.983. For 6 mt walk test the post values for Group A, mean is 14.07 ± 1.710 and the correlation is 0.859. For Group B the post values of 6mt walk test mean is 15.87 ± 2.031 , the correlation is 0.953. *Conclusion:* AFO group has shown the significant results and patients have improved the functional ability as per the results shown in the outcome measures.

Keywords: Ankle Foot Orthosis Functional Ambulation Category; Berg Balance Scale; Stroke; Balance; Locomotion.

Introduction

Prevalence rate of stroke in India is 84–262/1000, 000 in rural and 334–424/100,000 in urban areas.¹ Around 15 million individuals are getting affected

each year. Stroke can be life threatening condition. It is a worldwide healthcare problem that is serious and disabling.⁶ The consequences can be viewed as massive disturbance in the life of the patient and his/her family affecting physically and emotionally.⁶ Stroke causes muscle weakness, spasticity, debilitated sensorimotor control along with loss of psychological capacity, communication and behavior. Restoration of locomotion is one of the main goals of stroke rehabilitation.^{2,6} The ability to walk after stroke is very difficult due to the spasticity, weakness of muscles, compromised sensory-motor control and at times impaired cognitive functions. Most patients report walking as a major difficulty and priority as well.⁴ The loss of Postural control further causes problems with

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static and dynamic balance which increases the risk of falls and other secondary injuries. Stroke survivors with hemiparesis commonly show shorter step length, a longer stance phase along with a shorter swing phase of the affected side.^{8,6,13} Spasticity is one of the major problems impairing the extremities further affecting the Quality of Life (QOL) and functional independence. The patient experiences common patterns of spasticity occurring in standing, which includes flexion of the head, leaning to the hemiplegic side and rotation.³ Resulting in face toward the unaffected side and the upper extremities (UE) going in flexion pattern with a retracted scapula and depressed shoulder girdle.²

Many new approaches are being used in rehabilitation including body weight support treadmill training, functional electrical stimulation based orthosis, rhythmic auditory stimulation, robotic exoskeleton and virtual reality that are tried along with conventional rehabilitation to restore locomotion in stroke survivors.⁶ There have been many questions raised regarding the clinical effect, long term safety and cost benefit of these programmes thus an alternate rehabilitation approach is desirable.² Research has suggested that the outcomes of many of these are inconsistent and labor intensive, at the same time a customized Ankle Foot Orthosis has the potential to offer a better transition between sitting and standing beside preventing falls.⁴ Depending on the recommendations and reviews of previous research it has shown feasibility in rehabilitation following stroke as a clinical and functional advantage in rehabilitation.¹⁰

AFO should effectively work in regaining functional ability and provide base of support which assists in improving walking ability, if are not insufficiently stiff. AFO's prevents plantar flexion of foot during the swing phase of gait cycle and will provide ground clearance.^{6,12} They will thus, restore ankle function and should improve the balance and locomotion after stroke. The AFO provides a three point force system which is applied at the posterior side of the calf muscle, plantar surface of the foot near the metatarsal heads⁵, along the dorsum of the foot, which helps the ankle maintain a better position. AFO's along with improving the biomechanics of ankle joint, also will indirectly change the hip and knee alignment.⁷ This may occur by realigning the tibia to a normal position at nearly 10 degrees forward inclinations. Weight bearing on foot is redistributed to the plantar surface compared with the lateral aspect of the foot which shifts the ground reaction force (GRF) to the posterior side.³⁻⁵ During stance phase,

the GRF which is posteriorly positioned influences both the knee and hip joints. Hyperextension is prevented at the late stance phase if the GRF is closer to the knee joint. The GRF alteration position also will further change the alignment of hip joint anteriorly, which helps in reduction of abnormal flexion movement at the hip during the terminal stance. This adaptation of the GRF on both the knee and hip joints normalizes the demand on the affected limb by improving the control and stability during walking.^{2,3} Keeping the above potential benefits in mind the current study aims to find the effect of AFO on balance and locomotion in post stroke patients.

Subjects and Methods

This study was conducted in Physiotherapy Centers in Noida. 62 stroke survivors attending physiotherapy OPD were screened according to the inclusion and exclusion criteria.

Inclusion Criteria:

- Stroke survivors of both genders.
- Patients who can walk 10 meters.
- Age 18-60 years.
- At least 6 months but not exceeding one year.
- Patients with intact ability to follow commands and good at comprehension.

Exclusion Criteria

- Myocardial infarction, angina in recent 6 months.
- Global aphasia.
- Brain stem lesions, cerebellar, hemispheric lesions, recurrent stroke.
- Significant visual deficit, orthopedic problem which affects the participation.

Protocol

30 subjects meeting the selection criteria participated in the study. A brief explanation about the procedure to be followed was given to patients after receiving the written informed consent form.

The baseline data was collected on first day itself, which included three scales the Berg Balance Scale (BBS), Functional Ambulation Category (FAC) and 6 meter walk test (6 mWT). The patients selected for the study have been divided into two groups A & B,

in which Group A is provided with a non-hinged thermoplastic custom made ankle foot orthosis (Fig 1) and Group B is without the AFO. The patients are treated for 10 sessions (5d/week) for two weeks. Both the groups received an activity based therapy consisting of strengthening of lower extremity by resistive exercises, sit and stand reaching, treadmill training, balance, locomotion training, stair ascent and descent. Both the groups received the same exercise protocol, where group A performed with the AFO and group B performed it without it.



Fig 1: Non-hinged thermoplastic custom made orthosis with the footwear



Fig 2: Non-hinged thermoplastic custom made orthosis without the footwear

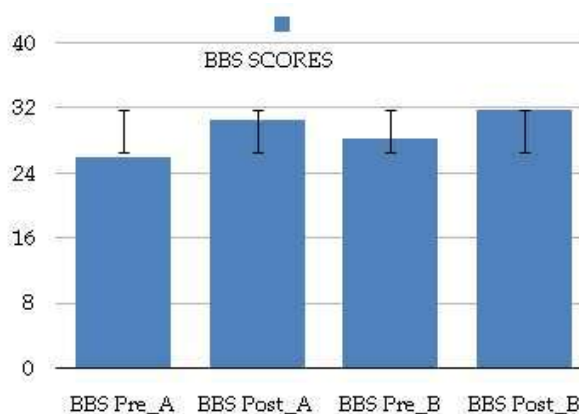
Statistical analysis

All the statistical tests are performed using the IBM SPSS software for Mac version 20.0. Paired and unpaired *t* tests are used to compare both intra and inter group pre and post results. A *p* value of ≤ 0.05 was considered as statistically significant. Descriptive analysis was done for the FAC results.

Results

Out of 30 stroke patients 4 were females and the rest 26 are males. The age of the participants ranged from 33–60 years. 3 patients were left hand dominance and 27 were right handed. Time period of onset of stroke was 24 to 37 weeks. In both groups the mode of FAC was 2 at the beginning of the session. The baseline chi-square value for both the groups was 0.839 and for BBS and 6mt walk test is shown in Table 1.

Group A showed 18.75% and group B showed 8.82% improvement in the FAC scores. Group A showed 17.69% and group B showed 12.97% improvement in the BBS scores. Group A showed 18.25% and group B showed 13.13% improvement in the 6mt walk scores. The results of paired and unpaired *t*-tests are shown in Table 2 and 3 and graph 1 and 2. Cadence and walking speed seemed to be significantly increased in the patients who walked with AFO. Walking speed has proved as one of the main outcome measure along with balance.



Graph 1: BBS pre and post values of both groups

Table 1: BBS and 6 mtWT

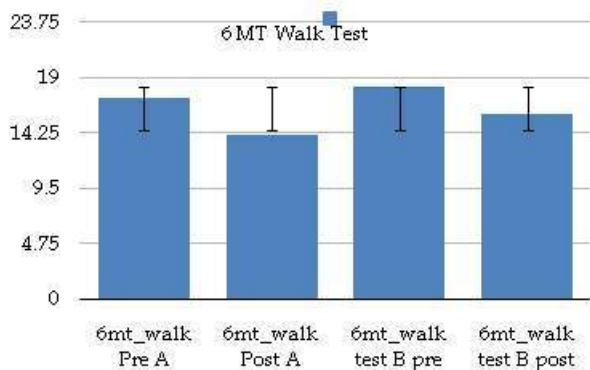
Outcome Measure	Group	n	Baseline Data on day 1		10 th Day Reading	
			Mean	SE	Mean	SE
BBS	With AFO	15	26.00 ± 3.047	0.787	30.60 ± 3.661	0.945
BBS	Without AFO	15	28.27 ± 4.431	1.144	31.93 ± 4.877	1.259
6 MtWT	With AFO	15	17.20 ± 2.178	0.562	14.07 ± 1.710	0.441
6 MtWT	Without AFO	15	18.27 ± 1.792	0.463	15.87 ± 2.031	0.524

Table 2: Results of Paired t-tests within group A and B

Outcome parameter	Group	N	Mean	SD	SE	95% Confidence Interval		t	df	Sig Value
						Lower	Upper			
						BBS	A			
	B	15	-3.667	0.976	0.252	-4.207	-3.126	-14.552	14	0.000
6 mt WT	A	15	3.133	1.125	0.291	2.510	3.757	10.783	14	0.000
	B	15	2.4	0.632	0.163	2.050	2.750	14.697	14	0.000

Table 3: Results of Un- Paired t-tests between group A and B

Outcome parameter	Mean Difference	SE Difference	t	df	Sig Value
BBS Pre	2.267	1.389	1.632	28	0.114
BBS Post	1.333	1.574	0.847	28	0.404
6 mt WT Pre	1.067	0.728	1.465	28	0.154
6 mt WTPost	1.8	0.685	2.626	28	0.014



Graph 2: 6 mt WT pre and post for both groups

Discussion

The improvement for the locomotion and balance after stroke has been a key area of research among neurological disorders and several strategies had been devised to restore the ability of walking in stroke survivors.¹⁰ This study focused on analyzing role and benefits of AFO in improving locomotion parameters. The result of the current study, shows that patients improved their locomotion and balance with AFO. Functional ambulation which was measured by FAC²¹ was increased when the patients with stroke wear AFO and walk. As in stroke the most particular feature of stroke is decrease in locomotion and balance.^{6,8}

AFO also seems to have an influence on the modification of the joint alignment of the affected side lower extremity, along with improvement in walking speed and functional ability.^{11,5} The 6 mtWT has been showed an improved walking speed as the decrease in duration of walking time is noted.^{16,14} It is also noted that there is improvement in balance which was measured by BBS.^{9,18} In a study by Iwata

et al., it was shown that an inhibitory bar can be attached an AFO which can be worn by the patients suffering from hemiparesis and it was concluded that there will be increased gait velocity of nearly 13% and significant increase in cadence^{2,11,14} while measured with 10 mt walk test by comparison between 2 groups wearing a chignon AFO and another group wearing a rigid AFO seemed to have the significant differences in the velocity of gait, but there were no changes in cadence.²

In comparisons between AFO and without AFO group, significant improvements have been observed in the locomotion, gait velocity and balance. The results are in line with previous studies which also demonstrated the functional benefits like improvement in gait, cadence and balance with AFO usage. Decrease in ankle dorsiflexion is a very commonly seen as a disturbance that occurs in stroke patients⁸ during swing phase. Normally in mid swing the ankle should be at neutral position through the initial contact. Ankle in neutral position during this period of foot clearance is provided by the AFO and thus, prevents the toes from touching the ground. This study has further concluded that AFO improves dorsiflexion in swing phase and initial contact as seen in the improvements of walking speed, balance and locomotion. The functional ambulation which was measured with FAC²¹ score showed the improvement. In future a follow up could be studied to see the retention effect of the AFO also an electromyography of the ankle muscles could be studied to see the effects of wearing of an AFO.

Conclusion

Ankle Foot Orthosis should be utilized to improve the balance and locomotion in post stroke patients.

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